APPENDIX A

Interface Control Document
for integrating a Ground Vehicle
into the V-22 Osprey Tiltrotor Aircraft

Marine Corps Systems Command, Quantico, Virginia
Naval Air Warfare Center, Patuxent River, Maryland

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INTERFACE CONTROL DOCUMENT

Scope

This document describes the critical interfaces between the V-22 Osprey Aircraft and all internally transportable ground vehicles and their accessories. The objective of this document is to provide clearly defined air transportability constraints for the development of internally transportable ground vehicles.

Background

In order to support the development of V-22 transported vehicle systems, it is necessary that V-22 payload constraints be formally defined and tracked. The intent of this document is not to interfere or limit the development of the V-22, but rather to ensure early definition and coordination of critical interface constraints for V-22 transportation of ground vehicles. The data presented here represents a subset of the V-22 Cargo Loading Manual. The data within this document publishes some items that are not defined in the Cargo Loading Manual yet (such as floor loading) and MV-22B aircraft #19 configuration, and specific analysis (such as C.G) for the ITV program. The Cargo Loading Manual will be updated in the near future to include floor loading and aircraft #19 configuration.

Aircraft Configuration and Constraints

Cargo Compartment

The cargo compartment, Figure 1, is 250 in (20 ft 10 in) long, extending from station 309 to the cargo ramp hinge at 559.2. Width is a constant 68 in when the troop seats are in the stowed position. Although the width of 68 inches is constant, a maximum of width is 64.5 inches is usable, depending on the cargo carried to allow the buffer boards to travel in their full range of motion for troop seating. Minimum cabin height is 66.2 in for palletized cargo and light wheeled vehicles. Wheeled vehicles having parameters in excess of the V-22 floor loading baseline capability will require shoring in the cabin for transport that will, effectively shrink the V-22 envelope height, currently estimated up to two inches of shoring. Figure 2 represents the envelope available for cargo loading at FS 559. The cabin cross-sectional area for cargo transport is constant through the length of the cabin.

The cabin incorporates a flip-over roller rail system. See Figures 3 and 4. This system, when stowed, protrudes 0.62 in above the floor and is 3.6 in wide. The guides are removable and are stowed in the cabin, but the guide tracks remain in place.

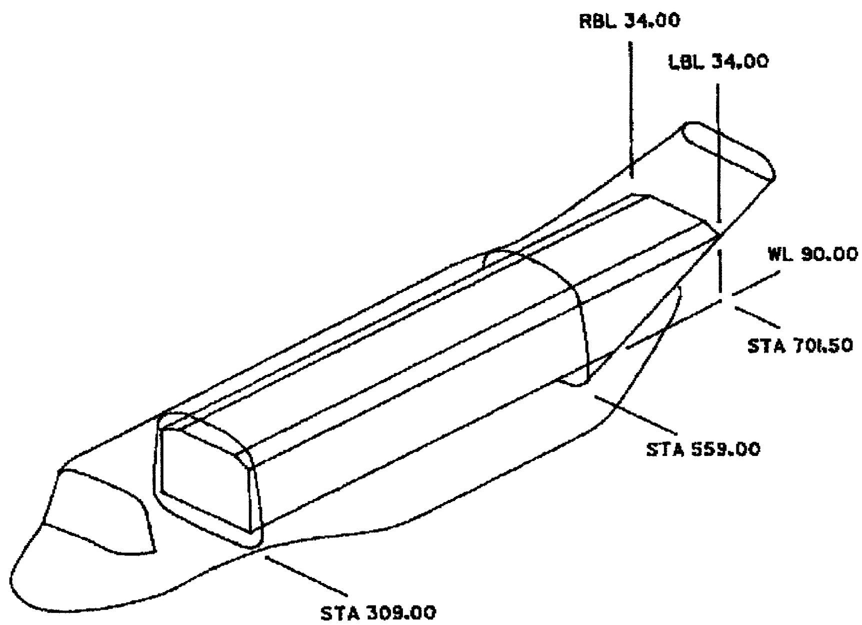

Figure 1. Isometric of V-22 Cargo Envelope.

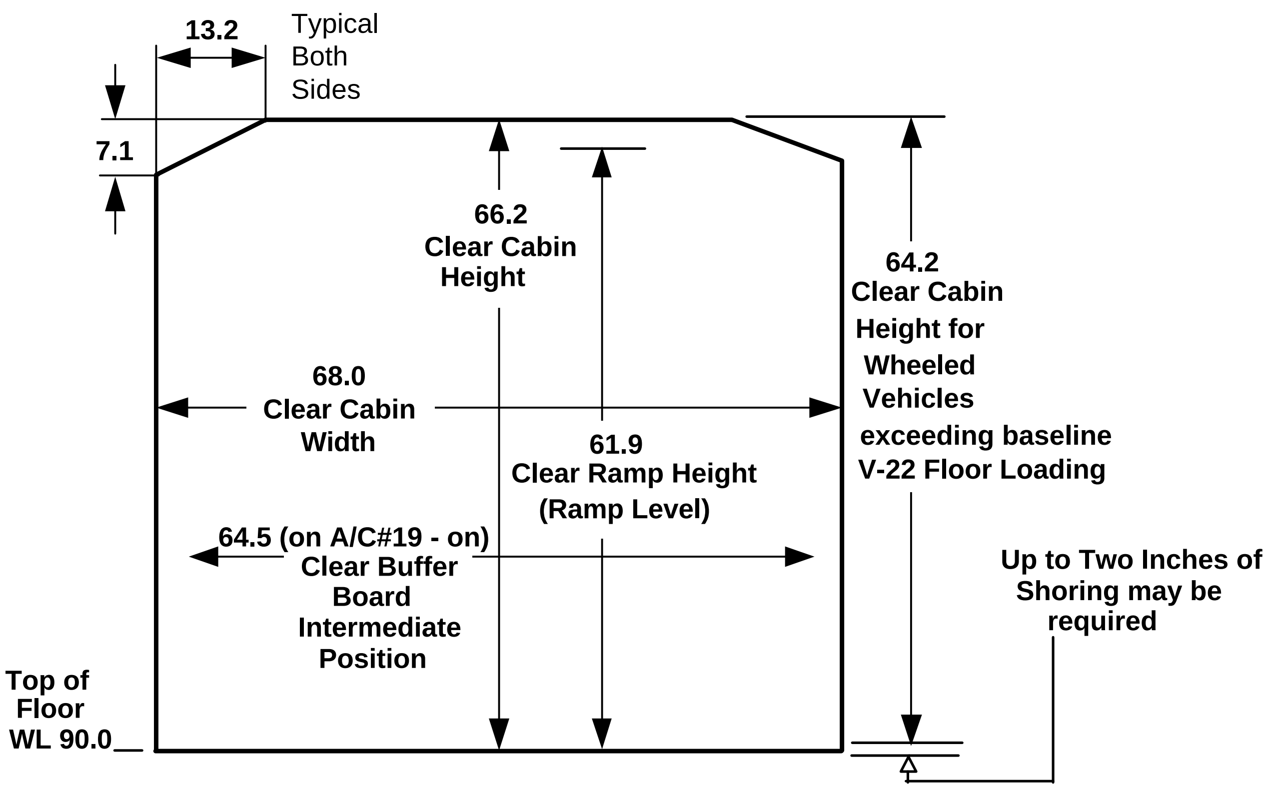

Figure 2. V-22 Cargo Envelope Cross Section at FS 559.

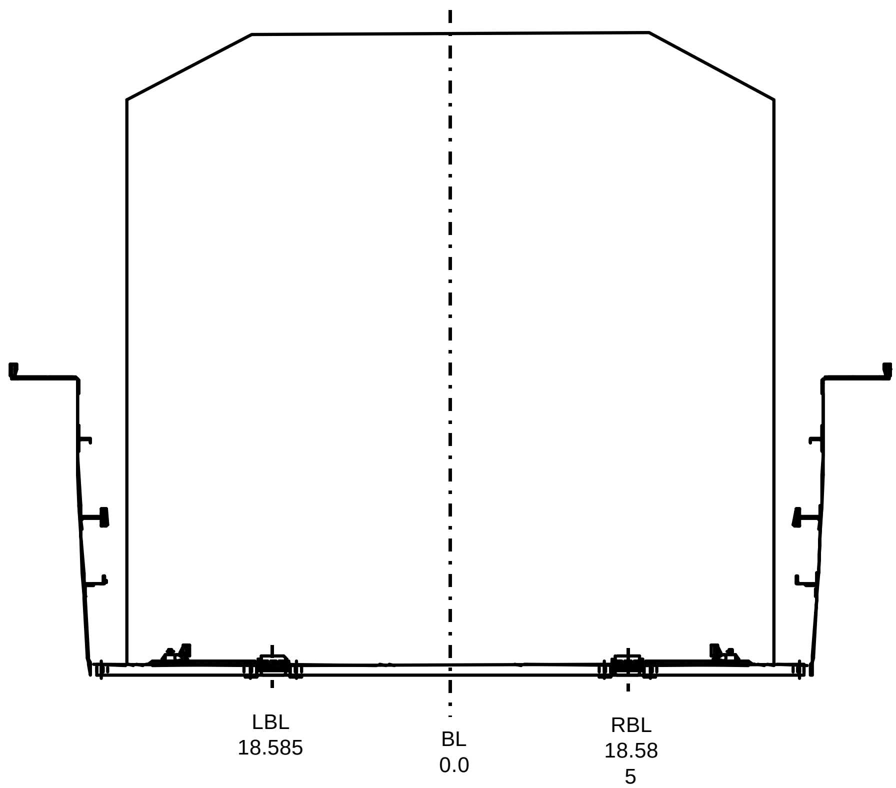

Figure 3. Cabin Cross Section with Flip-over Cargo Roller Rails.

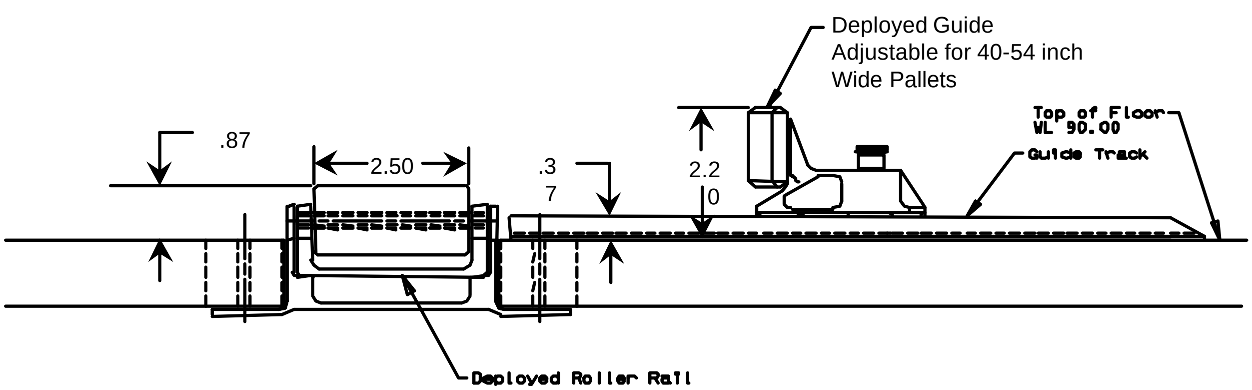

Figure 4. Details of Flip-over Cargo Roller Rails (right side, typical).

Cargo Compartment Ramp

The cargo ramp, Figure 5, provides rapid loading and deployment of troops and cargo. The ramp has a maximum break over angle 18.5 degrees.

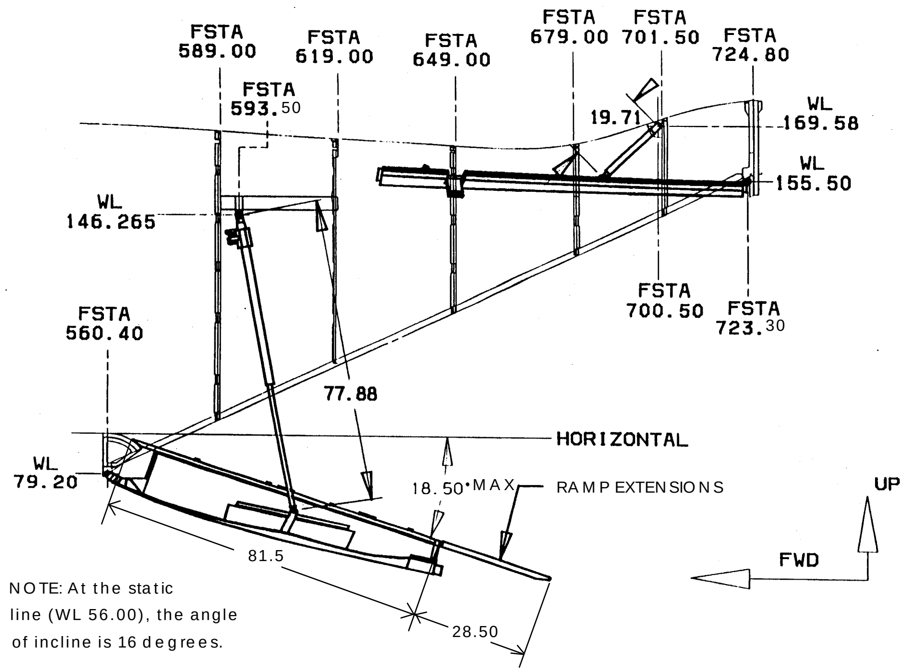

Figure 5. Ramp Opening Dimensions - Maximum Angle of 18.5 degrees.

Cargo Buffer Boards

Buffer boards, one on each side, are installed underneath the last four troop seats in the aft section of the cabin. Each buffer board is deployed by swinging the buffer board up and pushing it in, to lock it in place, Figure 6. The buffer boards are designed to be deployed when loading and unloading wheeled vehicles to protect the troops seats and/or structure from damage. Their intent to provide a line of sight for the crew chief to know that the vehicle is getting close to the seats/sidewall. The buffer boards are not to be used as a physical contact guide for the vehicle to react against in the event the vehicle is not aligned dead center.

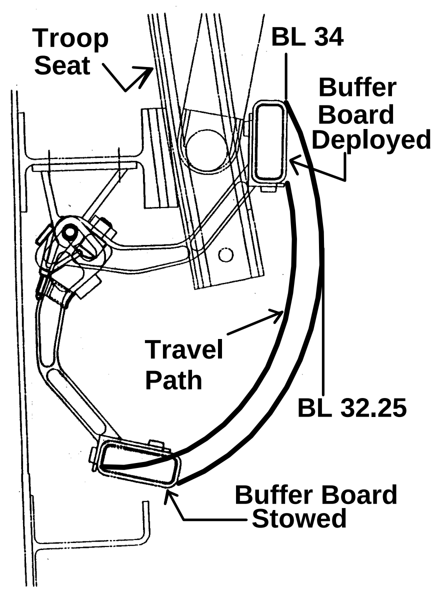

Figure 6. Travel Path In Order to Deploy/Stow Buffer Boards.

In order to allow the buffer board to go from deployed to the stowed position, the buffer board path of travel must extend into the cabin cargo envelope by approximately 1.75 inches on each butt line side. Therefore, a useable cabin width of 64.5 inches is available to allow the buffer board to be stowed to get the seat pans down for transport of vehicle driver and crew after the vehicle is driven on board the aircraft. If the vehicle loading is found to be extremely difficult to centerline before boarding the aircraft, that tolerance amount is required to be taken into account in vehicle width to allow for the 1.75 inches to be always available on all sides for buffer board stow/deploy functions.

Floor Loading

Three flooring areas of the V-22 need to be reviewed for their limitations such that the tire contact area and the tire load does not exceed the aircraft capabilities and cause damage.

The three flooring areas are: ramp tunnel, ramp and the cabin floor, as identified in Figure 7

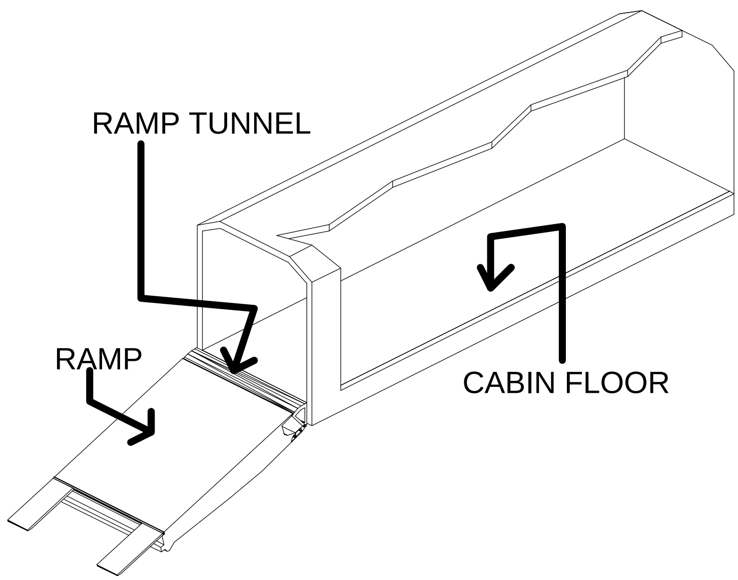

Figure 7. Three Flooring Areas Identified

Each flooring area has a separate chart to identify the limitations and known shoring requirements. These charts are shown below, Figures 8,9,10.

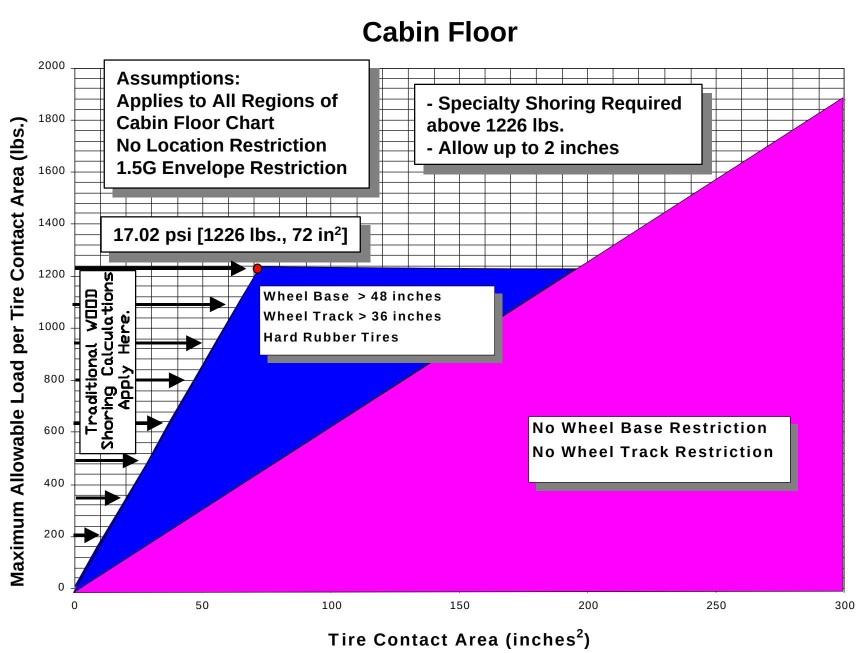

Figure 8. Cabin Floor Limitations/Restrictions

Ramp Tunnel

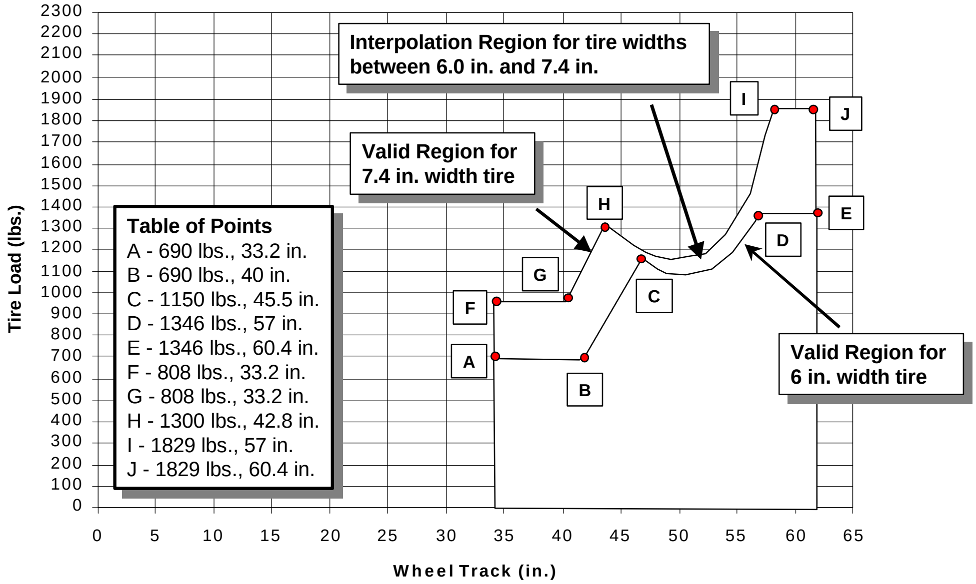

Figure 9. Ramp Tunnel Limitations/Restrictions

The ramp tunnel is incapable of being shored to assist in axle load distribution. In an effort to support wheeled vehicle activity, the Government has requested an ECP from the aircraft manufacturer to determine the impacts of structurally enhancing the ramp tunnel to accommodate predicted axle loads of the ITV. Upon receipt of this ECP proposal, the Government will decide the appropriate action to take. The effectivity of the change and retrofit is not known. Presently and until otherwise stated, the Ramp Tunnel Chart presented here is to be utilized.

Ramp

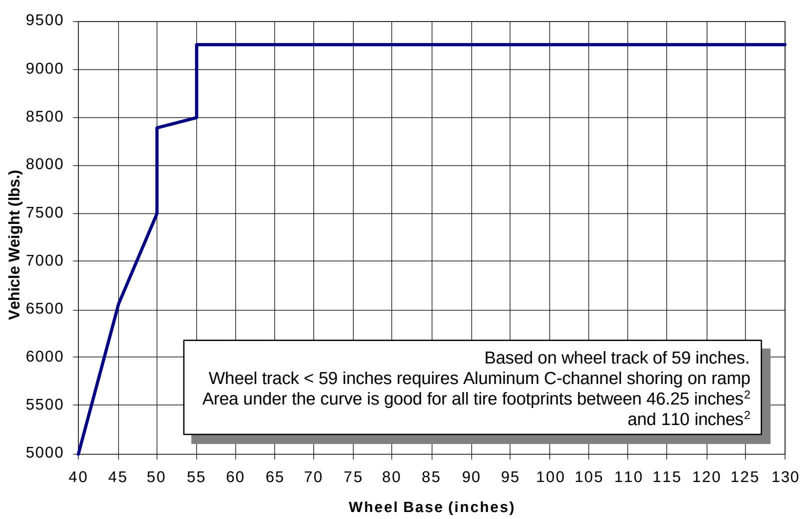

Figure 10. Ramp Limitations/Restrictions

NOTE: As chart reads now, even the lightest of vehicles with less than a 59 inch wheel track will require this aluminum "C" channel rolling shoring on the ramp.

Cargo Floor Tiedown Pattern

Cargo is secured by 40 tiedown rings on the cabin floor and 4 tiedown rings on the ramp floor. The tiedowns are arranged in four rows and are spaced on an approximate 20 in grid pattern. There are 22 – 3.5K rated tiedown rings and 18 - 7.0K rated rings (Figure 11) on the main cabin floor. The rings, mounted in waterproof pans, can swivel through a full 360 degrees and stow flush with the floor when not in use. An additional 6 tiedowns are attached to frame locations on the aircraft wall, FS 371, FS 422 and FS 505, to support the cargo barrier net or cargo straps. See Figure 12.

Rings utilized for restraint must be reachable by flight crews. Rings located underneath seated occupants cannot be used because tiedown devices under the seat would not allow full stroking capability of troop seat.

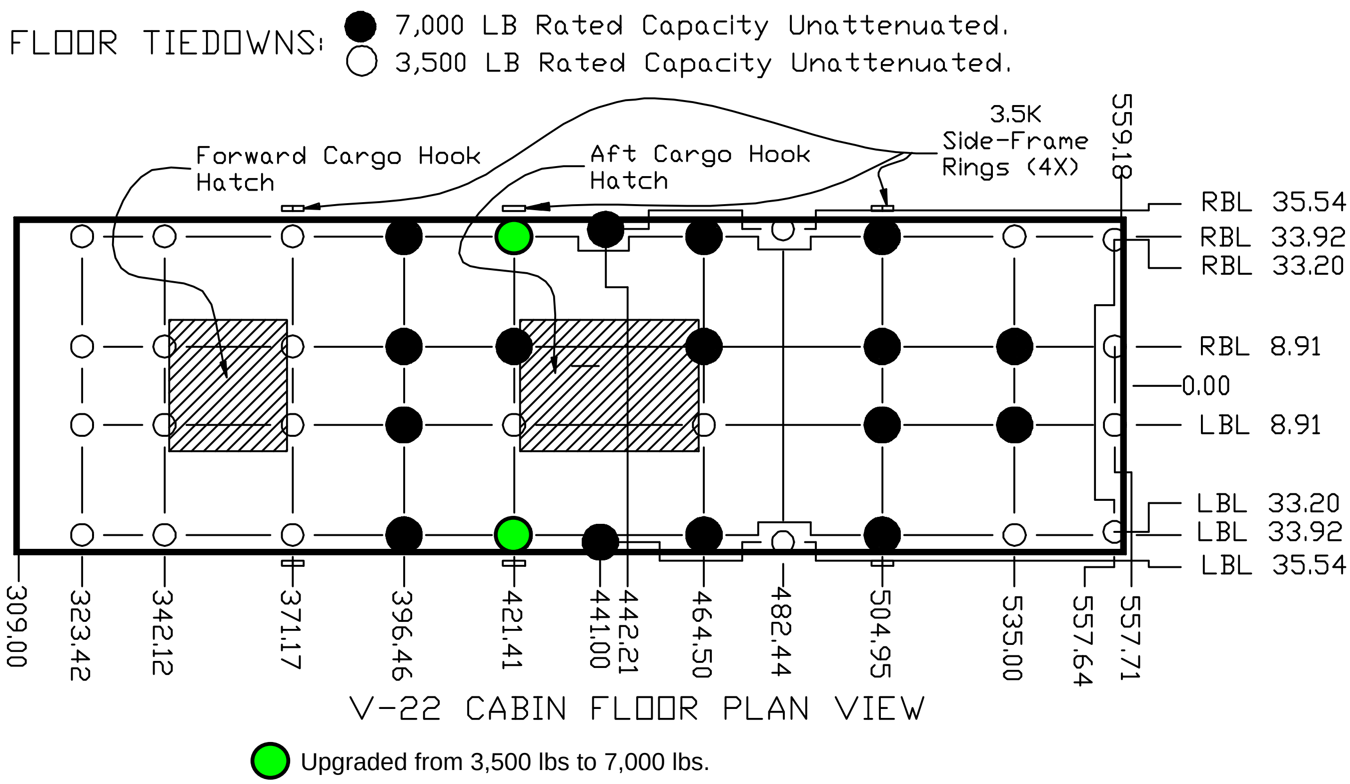

Figure 11. V-22 Cabin Floor Plan View Showing Floor Tiedown Pattern.

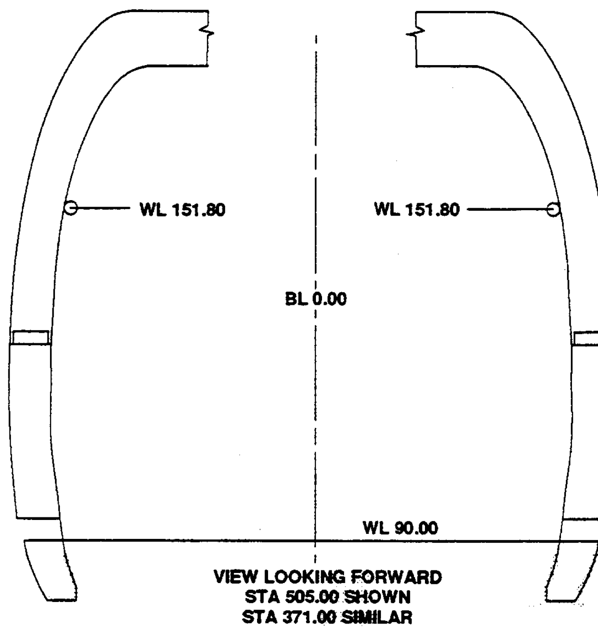

Figure 12. Aircraft Frame Tiedown Fittings Location.

Cargo Restraint Critiera

Cargo may be subjected to forces resulting from flight in rough air, accelerations caused by flight maneuvers, and rough or crash landings. These forces act more strongly in some direction than in others, and will shift cargo unless it is properly restrained. Since aircraft and cargo both move forward rapidly during normal operation, cargo will tend to keep on moving if the aircraft is suddenly slowed or stopped. This forward force is likely to be the strongest force acting on the cargo, but the cargo must also be secured against the forces acting upon it laterally, vertically or in an aft direction. The amount of restraint that must be used to keep cargo from moving in any direction is "restraint criterion", and is expressed as the units of the force of gravity, or Gs. The Gs required to be restrained in the four directions are:

8G Forward
2.0G Aft
3.0G Lateral - NOTE: ***Review of Flight Test Data Indicates Lateral G Will Increase***
2G Up

Troop Seat Configuration

The aircraft will be equipped for 24 troop seats and a crew chief. See Figure 13. Twelve (12) troop seats are provided along the left-hand side and 12 troop seats and a crew chief seat along the right-hand side. If there is a cargo mix of wheeled vehicles and troops, the vehicle driver and all passengers must be seated in the troop seats during the transport of the vehicle. The crew chief seat (top left corner) is centered on FS 320.1, ends at 330.1 and the remaining seats are spaced at 20 in intervals.

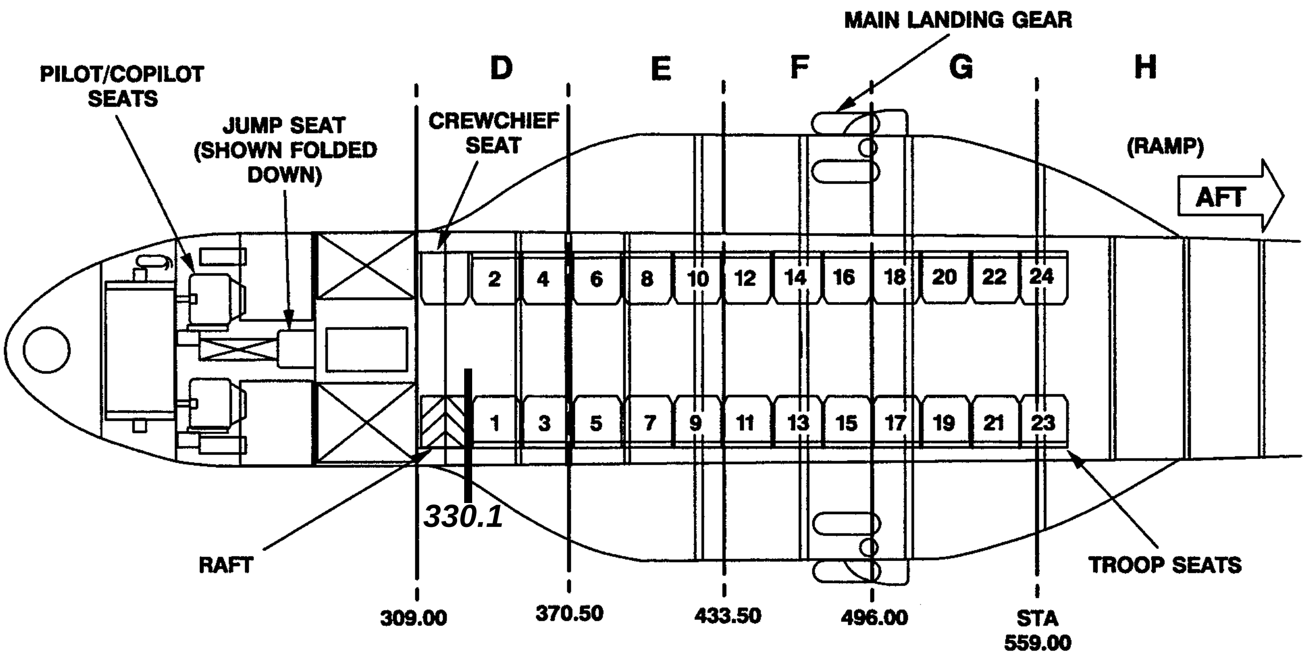

Figure 13. V-22 Troop Seat Configuration.

External Cargo Hooks

The V-22 has two external cargo hooks as shown in Figure 14. Each hook has a rated capacity of 10,000 lb and the hooks can be used in tandem for load stabilization up to a maximum total capacity of 15,000 lb. The V-22 is capable of transporting loads externally up to its maximum rated engine power (typically not more than 250 knots for most loads); however, air loads and dynamic response limitations of the carried load may limit aircraft speed.

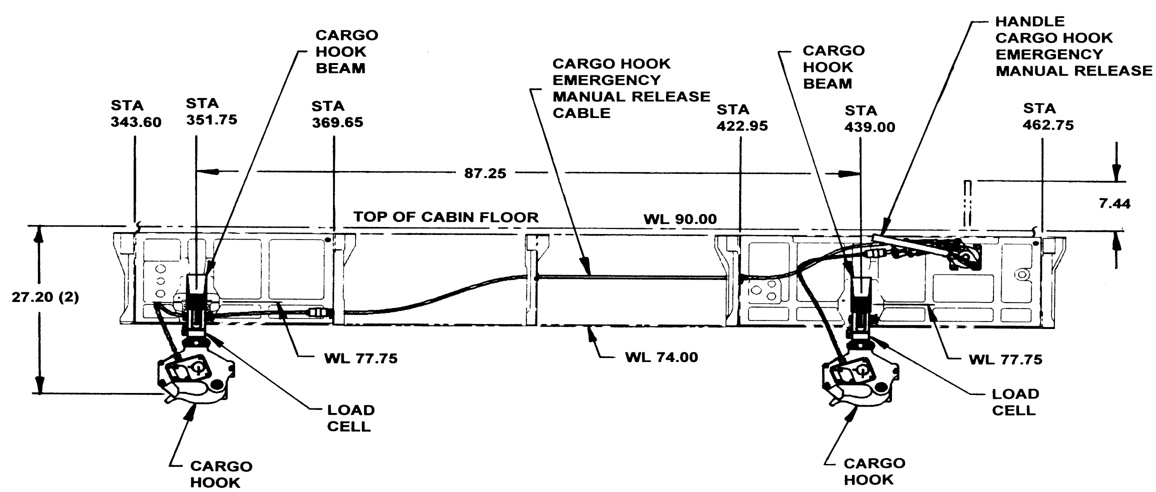

Figure 14. V-22 External Cargo Hooks.

Emergency Egress

In the event of a crash, the V-22 cabin provides two pyrotechnically released panels on the cabin left side and one on the right side in the aft cabin. In addition to the manual emergency egress in the upper cabin entry door there is a manually released maintenance access hatch located overhead in the aft fuselage that also serves as an emergency egress point. The hatches are all Class C emergency exits. The upper segment main cabin door is a Class C exit within a Class A door, which is used in the event of jamming. All emergency exits as shown in Figure 15 are designed to permit evacuation of the passengers within 60 seconds using half of the aircraft exits. The ramp may also be utilized for escape purposes by accessing the ramp control panel in the aft cabin if the hydraulic systems are still functional, but this is not an approved emergency egress point.

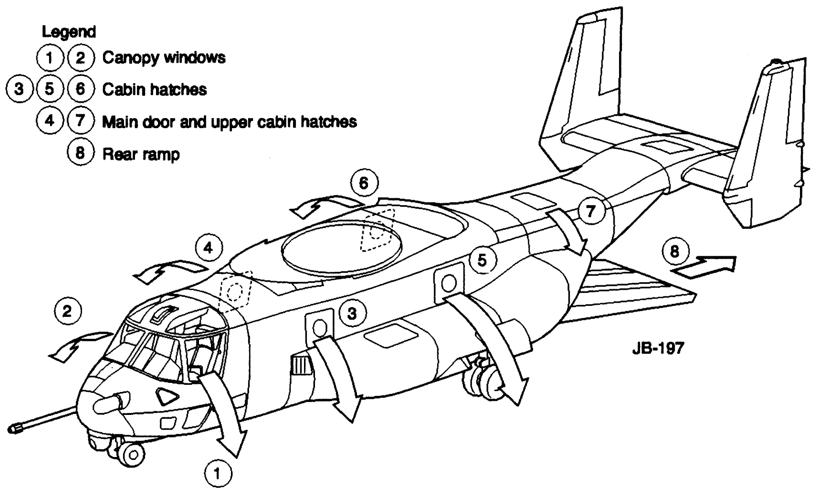

Figure 15. Emergency Egress Locations.

Data and Communications Interface

The V-22 is supplied with a troop commander's station in the middle of the cabin. This station currently provides access to the intercom system and to the low data rate data interface through the aircraft radios. Plans are in place to augment this station with a full interface to the aircraft's onboard MIL-STD-1553 databus for access to aircraft status parameters, threat and EOB updates, and higher data-rate digital communications. TIBS and TDDS data can be provided at this improved access station. There are currently three connectors on the cabin panel: MLV Power, MLV Data and ARC-210 Fill. The location of the panel is on the Left Hand Avionics Rack at ST 279.5, WL 139.8, BL -17.4. The Radio Fill Port is used for digital communications and is a MIL-STD-1553 interface. The procedures for communicating or transmitting data on the aircraft radios from the cabin are different for the two types of radios integrated into the V-22.

AN/ARC-210 (RT-1747A/ARC)

For the AN/ARC-210 (RT-1747A/ARC on the MV-22), the ARC-210 radio itself is data capable when interfaced with a suitable external data device, either via the analog I/O or via the wideband I/O (clear or secure). Typical applications of analog data are Frequency Shift Keyed (FSK) such as the Automated Target Handoff System (ATHS), Improved Data Modem (IDM) or the DBMT carry on device. These operate using two-tone FSK. For normal voice communication over the radios, a digital connection is not necessary. Cabin occupants hook up a headset to one of the Intercom Station Control (ISC) boxes, tune the radio and communicate in a normal fashion (using push-to-talk, hot mike or call). For digital data on the MV-22, a Digital Burst Message Terminal (DBMT) hook up to one of the Intercom Station Control boxes is used in place of a headset. This uses the HF/VHF output on the DBMT. The MV-22 performs the I/O via the Communications Switching Unit (CSU) to connect an ATHS II or IDM to both radios. The ATHS/IDM operates at adjustable rates up to 1200 bps (i.e. TACFIRE, AFAPD, etc. protocols). The keyboard operates at approximately 300 bps in ASCII.

AN/ARC-210 (RT-1749(C)/ARC)

For the AN/ARC-210 (RT-1749(C)/ARC on the CV-22), the radio offers many possibilities for data capability. This version of the ARC-210 is designed with embedded VMF messaging, DAMA, and COMSEC which provides several options for a cabin data hook-up. This radio also has a MIL-STD-188-114A port on the back of the radio (J8) to allow hook up to an external data device (i.e. laptop computer) for sending data via DAMA. Data can be sent to the radio at a minimum of 2.4 kbps. This capability would also have to be configured by the pilot via the Black 1553 control bus. The DBMT can interface to the MIL-STD-188-114A I/O on the radio. The radio can operate in synchronous (external clock provided by data device) or asynchronous mode (internal clock based on data rate selected). Since the DBMT does not have a clock output, the asynchronous mode at 1200 bps would be used and the radio should be able to sync up. The RT-1749(C) also performs a message parser function for VMF. The IDM currently does not do that, but the Army has just started an upgrade to do that function. The upgrade should be available in 2000. Boeing is planning to use this on the CH-47 ICH in support of "JVMF Digital Battlefield".

The RT-1749 (like the RT-1747) retains the existing Black 1553 for control, and adds a Red 1553 for VMF Data Mode. The J8 port on the back of the radio is a Red 1553 Remote Terminal that allows VMF data mode. The V-22 would need a Bus Controller (i.e., laptop with 1553 card) added and connected to the back of the radio to transmit 16 kbps data. The pilot would enable the radio (i.e. tuning, COMSEC mode, Data Mode, Data Rate) via the CMS, since the setup must be done over the black 1553 control bus.

Tiedown Devices

The following are rules to be complied with when attaching tiedown devices to cargo and tiedown rings on the cargo floor:

a) Vehicle contractors must compute the number of tiedown devices required. Apply aft restraint devices in the opposite direction, but at the same angle, as the forward devices. Use the same attachment point on the cargo for attaching a forward and aft restraint device, if possible.

b) Always attach an even number of tiedowns in pairs for forward or aft restraint. Tiedown devices should be attached in a symmetrical pattern by connecting to opposite fittings across cargo floor centerline.

Vehicle contractors must define the location of the vehicle in the cabin that provides a proper tiedown pattern. Sufficient tiedown capacity should be identified and provided to account for a normal amount of variation in this preferred location.

Vehicle Tiedown

Vehicle tiedowns must consider restraint for the sprung and unsprung portions of the vehicle separately. The sprung portion of the vehicle consists of everything above the springs, such as frame, body, cab, load bed, and cargo in the vehicle. Cargo onboard the vehicle must be fastened to the vehicle. The unsprung portion of the vehicle which consists of everything below the springs, such as the wheels, axles and springs. When applying tiedown devices, do not permit them to chafe hydraulic lines, fuel lines, tires, or electrical wiring.

Some additional notes:

(1) Vehicle manufacturers are responsible for providing the tiedown pattern to NAVAIRSYSCOM.

(2) Each vehicle tiedown ring on the vehicle shall have a cone of action defined in Figure 16

(3) Structural load path substantiation (analysis and pull-testing) is required. Even items like wrapping a chain around an axle, will require analysis and pull-testing to validate the capability of that item.

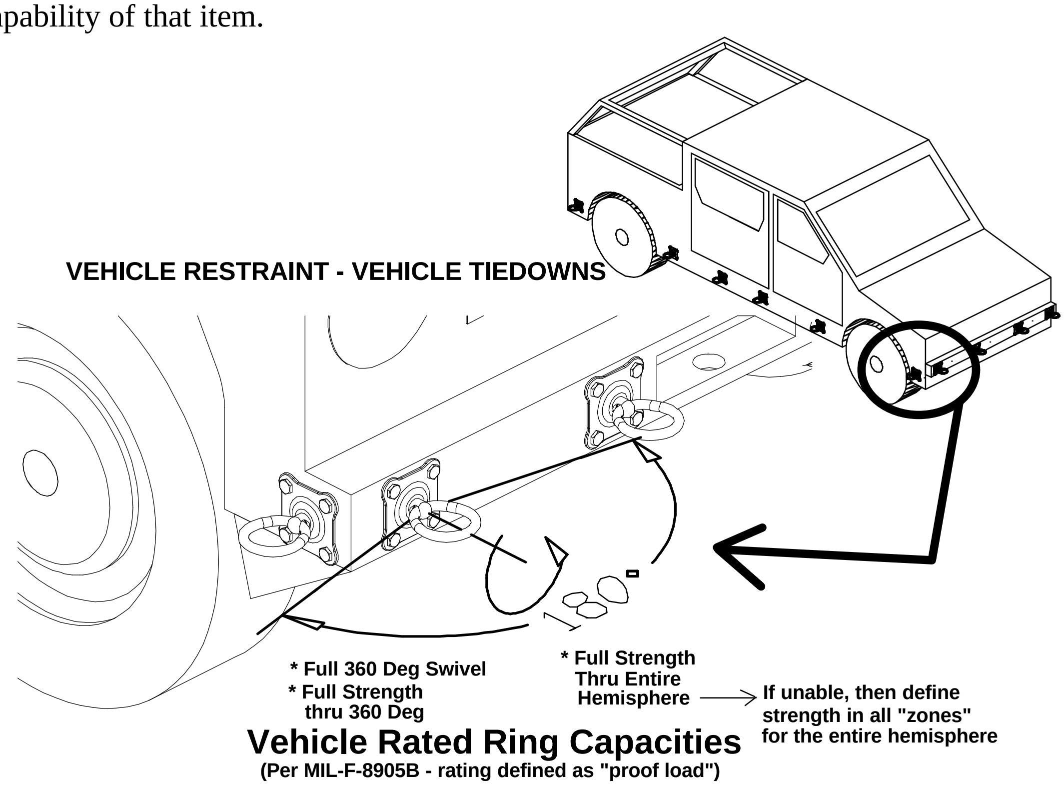

Figure 16. Vehicle Tiedown Requirements/Definitions

(4) The vehicle at the system level shall be required to meet the restraint criteria. Cargo within the vehicle, as well as on-board vehicle equipment can become a lethal projectile causing a fatality, even if the vehicle is restrained properly, if it is not equally restrained to react the G level.

Center of Gravity Limitations & Cargo Placement Planning

In general, the vehicle should be loaded as far forward in the cabin as possible, although certain center of gravity (CG) constraints must be met. A vehicle CG envelope has been defined specifically for 5,000 to 9,000 lb vehicles so that the overall aircraft CG is within its own envelope. This CG envelope is based on having a vehicle crew of three sitting in the most aft seats onboard the V-22 and the crew chief in his appropriate seat. This personnel configuration does not alone determine the starting length of the vehicle. Figure 17 illustrates the personnel seating positions and then the equation that should be used to determine the useable cabin length for the length of the vehicle. Envelopes are shown in Figures 18 through 21 for the various MV / CV-22 configurations. The configurations trade in/out the aft sponson fuel tank full, and the turreted nose gun. The nose gun is in the planning stages, therefore vehicles need to also comply with the "No Nose Gun" configurations.

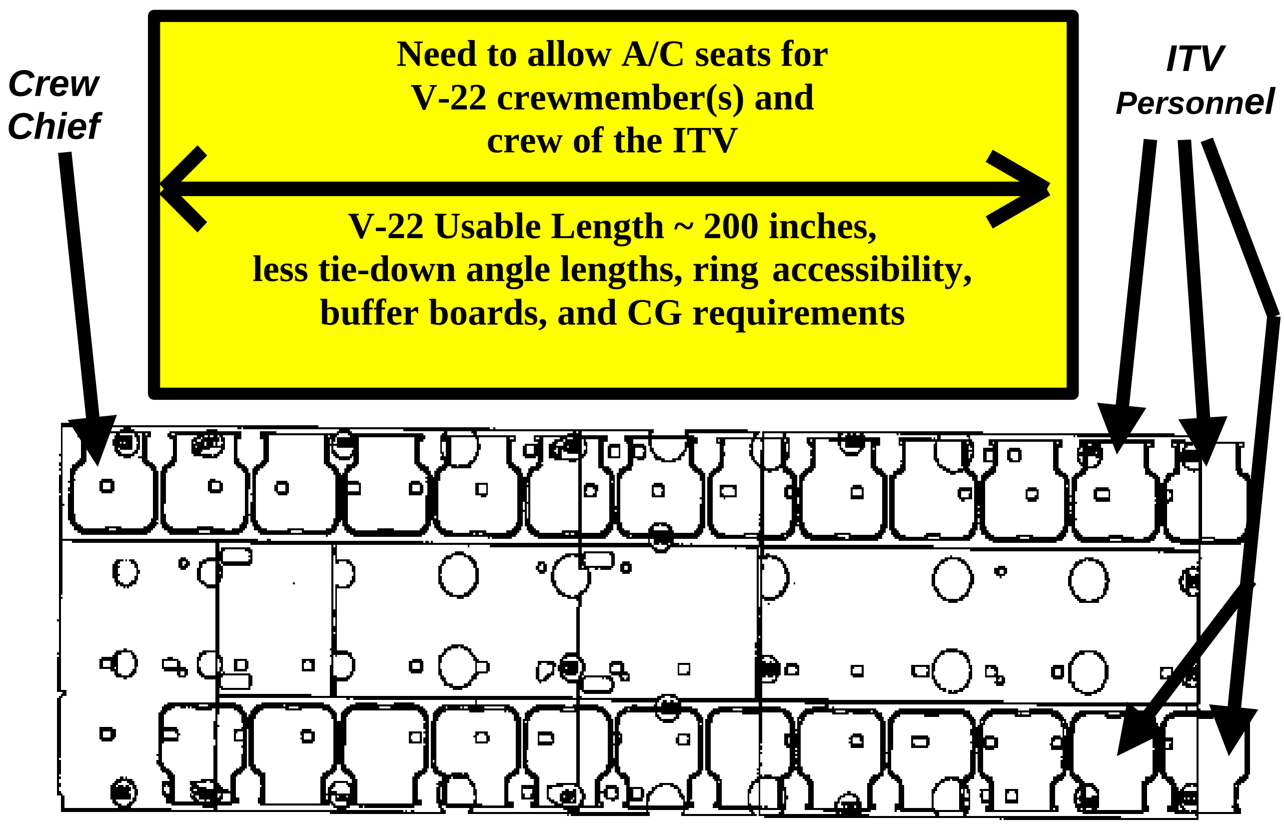

Figure 17. Factors for Determining the real length of the vehicle.

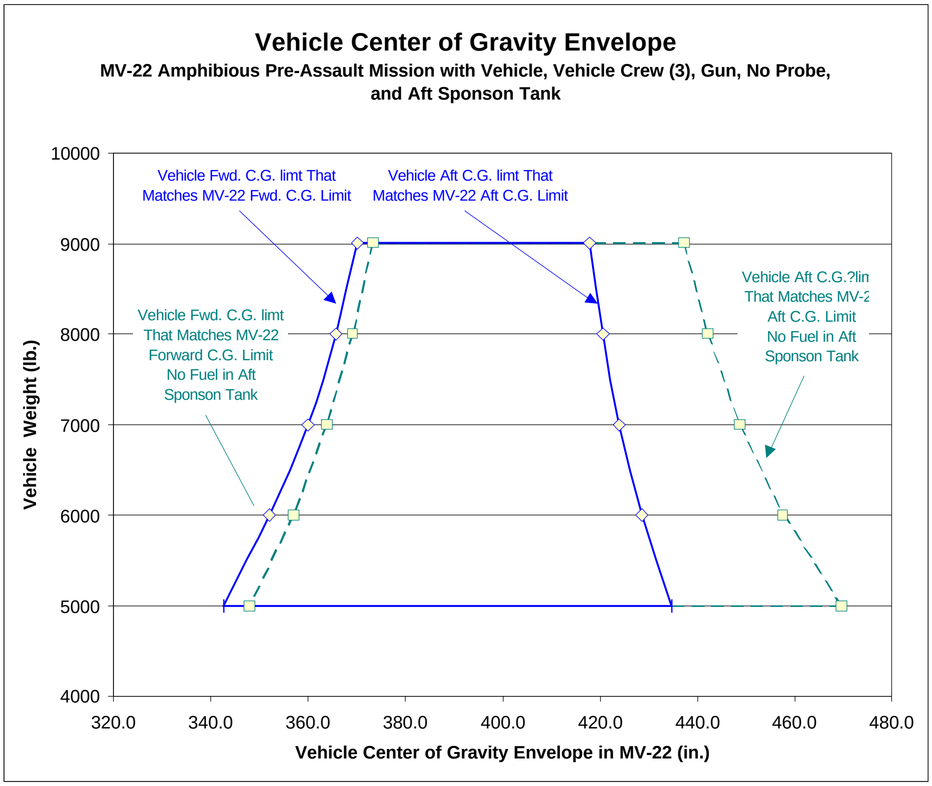

Figure 18. Center of Gravity Envelope for Ground Vehicles carried in the MV-22 WITH GUN.

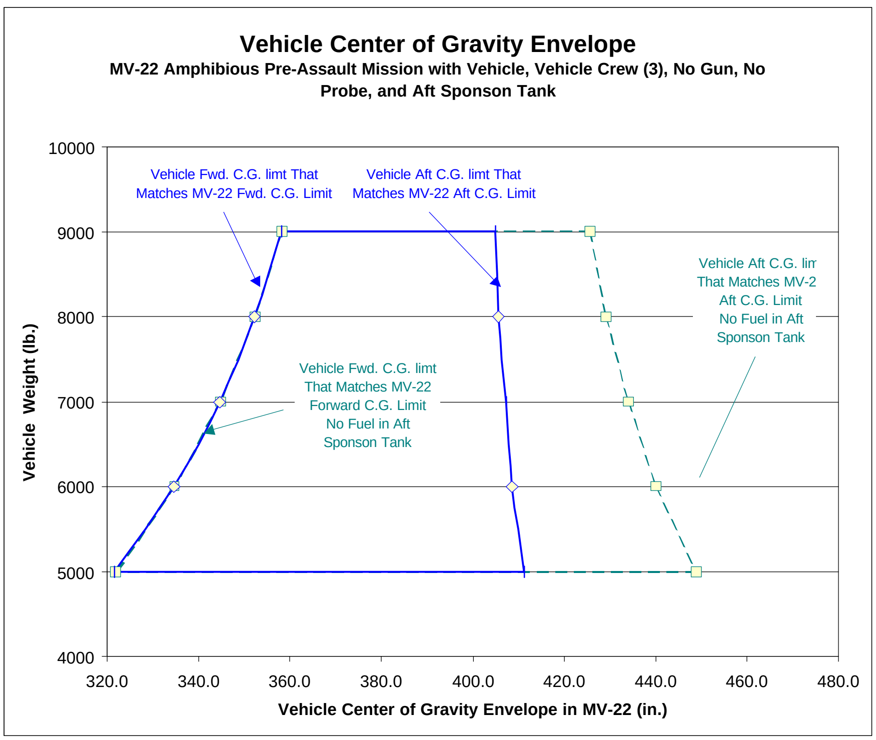

Figure 19. Center of Gravity Envelope for Ground Vehicles carried in the MV-22 WITHOUT GUN.

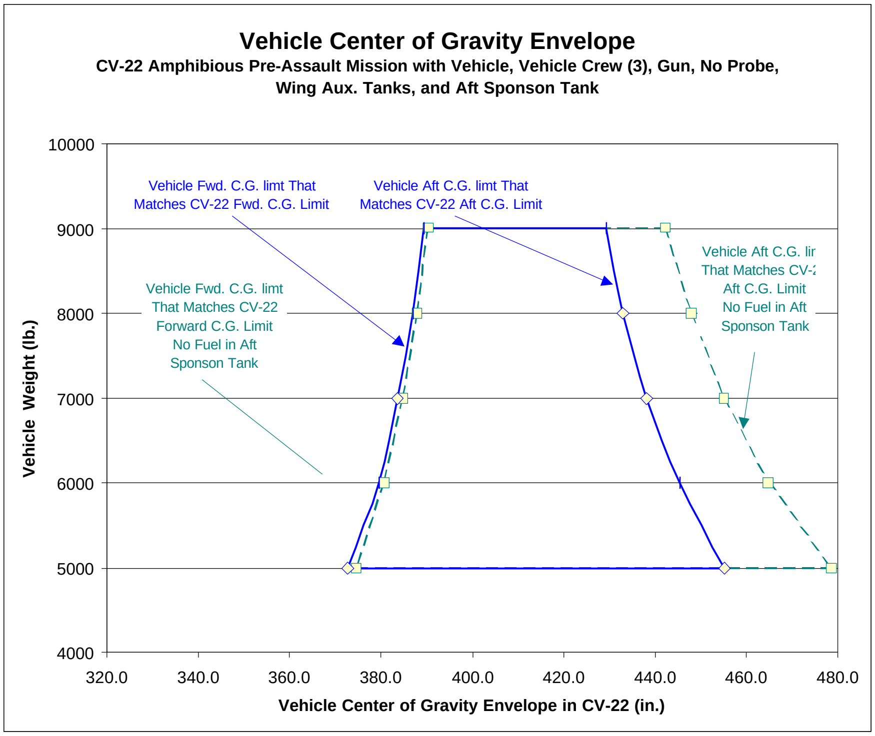

Figure 20. Center of Gravity Envelope for Ground Vehicles carried in the CV-22 WITH GUN

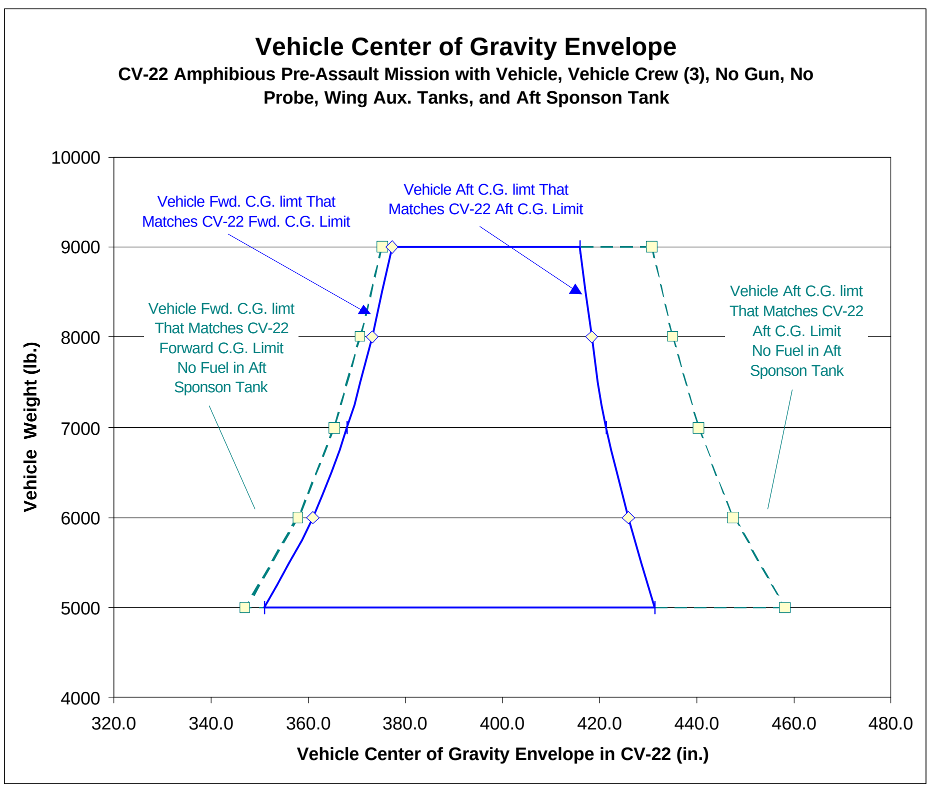

Figure 21. Center of Gravity Envelope for Ground Vehicles carried in the CV-22 WITHOUT GUN

Electromagnetic Interference Constraints

The intra-system electromagnetic performance of all aircraft equipment and internally transported vehicles shall operate together without mutual interference or degradation of performance in accordance with MIL-STD-461, Table II for Radiated Emissions (RE) and Radiated Susceptibility (RS) for Aircraft, Navy. With all avionics compartments in their normal (closed) positions, the V-22 is EMI hardened to 200 volts/meter from all directions, including internal to the cabin. The V-22 generates 20 to 50 volts/meter into the cabin.